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Sleep Onset, Melatonin, and Cortisol Levels on Vegetarian and Non-Vegetarian Communities in Denpasar, Bali

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ABSTRACT

Background. Sleep is a basic human need. Sleep disorders have become a concern in the health sector in recent decades. The type of food we consume considerably influences sleep biochemistry, including melatonin. Melatonin can trigger sleep by suppressing wake-promoting signals or neuronal firing in the Supra Chiasmatic Nucleus. The most explainable effect of melatonin's role in regulating sleep mechanisms is reducing sleep onset latency. The hormone cortisol is said to be a stress hormone as the end product of the Hypothalamic Pituitary Axis (HPA), which can disrupt sleep. No research has analyzed the differences in levels of these hormones and sleep onset in vegetarian and non-vegetarian groups. The study analyzed differences in melatonin, cortisol and sleep onset levels in vegetarian and non-vegetarian communities.

Methods. This research was an analytical observational study using a cross-sectional method. The research was carried out after obtaining approval from the ethics commission. All subjects had their blood levels of melatonin and cortisol checked and sleep onset assessed using a sleep tool. The data collected was then analyzed for differences between the two groups.

Results. This study involved 76 subjects from vegetarian (38) and non-vegetarian (38) groups. For the characteristics of the two groups, most of the subjects were less than 45 years old, married, had postgraduate education, and worked as private employees. Body weight was mainly average in both groups, but there was more overweight and obesity in the non-vegetarian group, namely 22.9% overweight compared to 21.1% in the vegetarian group. Obese in the non-vegetarian group was 15.8% compared to 7.9% in the vegetarian group, although this difference was not statistically significant (p=0.471). Cortisol levels in the non-vegetarian group were higher than those in the vegetarian group, although not statistically significant (p=0.779). Melatonin levels were higher in the vegetarian group, but this was not statistically significant (p=398). Most of the vegetarian group's sleep onset was less than 20 minutes, unlike the non-vegetarian group, whose sleep onset was more than 20 minutes. This condition is statistically significant with a p-value <0.001.

Conclusion. Cortisol or stress hormone levels were higher in the non-vegetarian group than in the vegetarian group. In contrast, melatonin or sleep hormone levels were higher in the vegetarian group, although neither condition was statistically significant. Clinically, the onset of sleep in the two groups was significantly different, where the vegetarian group had a faster onset of sleep than the non-vegetarian group.

Keywords: melatonin levels, cortisol, sleep onset, vegetarian, non-vegetarian

INTRODUCTION

People need sleep duration according to their age. Good quality sleep can prevent the emergence of diseases in the future, such as type 2 diabetes mellitus, heart problems, obesity, hypertension, stroke, and cognitive disorders, as well as other diseases. Diet patterns can be an option to improve sleep quality and avoid chronic diseases, one of which is using a plant-based or vegetarian diet.[1] Our sleep regulation is regulated by the homeostasis process and circadian rhythms involving the hormone melatonin. Stressful conditions can trigger sleep disorders by triggering the release of the hormone cortisol. In the general and vegetarian communities, food intake can be a source of serotonin converted into melatonin. Foods that contain carbohydrates are low in glucose and high in protein, fatty acids, and fibre, and they are said to improve sleep quality. The most apparent effect of melatonin's role in regulating sleep mechanisms is to reduce sleep onset. Anatomically and physiologically, it is found that there is mutual inhibition of sleep-inducing activity in the hypothalamic ventrolateral preoptic nucleus and wakefulness-inducing activity in the locus coeruleus, dorsal raphe and tuberomammillary nuclei, systems that can regulate sleep-switching. Melatonin can influence this switching mechanism and accelerate sleep onset through abundant receptors in the SCN. The role of melatonin in sleep maintenance depends on the duration and level of receptor desensitization, as well as the availability of melatonin in circulation during the sleep period.[2]

METHODS

This research is an analytical observational study with a cross-sectional design. The target population is all residents in the Denpasar city area. The accessible population during the research period is the vegetarian and non-vegetarian community in the Denpasar city area. The sample is an affordable population that meets the eligibility criteria. The inclusion criteria in this study were that all vegetarians who entered the vegetarian and non-vegetarian communities agreed to participate in the research, which was marked by signing an informed consent. Exclusion criteria include subjects having severe physical illnesses, severe medical and neurological illnesses, serious psychiatric disorders, currently taking medication that can affect sleep, currently taking medication that can affect blood levels of the hormone melatonin or cortisol, and not present at the time of data collection. This research has received approval from the Ethics Commission of the Faculty of Medicine, Udayana University, namely Ethical Clearance/Ethical Eligibility Statement Number: 160llllll:'1l4.2.2. Vll.I4lLT/2022.

RESULTS

This research involved 76 subjects who met the eligibility criteria. A total of 38 subjects were from the vegetarian group and 38 were from the non-vegetarian group. The following is a table of research subject characteristics:

Table 1. Characteristics of Research Subjects

		Vegertarian (n=38)	Non-Vegetarian (n=38)	p-value
Sex	Woman	14 (37)	16 (42,1)	0.815
	Man	24 (63)	22 (57,9)	
Age	<45	23 (60)	35 (92,1)	0.002
	≥45	15 (40)	3 (7,9)	
Marriage status	Not married	14 (37)	8 (21,1)	0.206
	Married	24 (63)	30 (78,9)	
Education	Undergraduate	18 (47,3)	4 (10,5)	0.001
	Postrgraduate	20 (52,7)	34 (89,5)	
Employment	Unemployed	5 (13,2)	6 (15,7)	1.000
	Employed	33 (86,8)	32 (84,3)	
BMI	Underweight	4 (10,5)	2 (5,3)	0.471

	Normal	23 (60,5)	19 (50)	
	Overweight	8 (21,1)	11 (28,9)	
	Obese	3 (7,9)	6 (15,8)	

From **Table 1**, the characteristics of the subjects in both groups were obtained, namely that the majority of subjects were less than 45 years old, although there were significant differences for the vegetarian and non-vegetarian groups. Most of the subjects were married, most had postgraduate education, although there were significant differences between the Vegetarian and Non-vegetarian groups. Most of the subjects in both groups worked as private employees. Body weight was mostly normal in both groups, but there was more overweight and obesity in the non-vegetarian group, namely 22.9% overweight compared to 21.1% in the vegetarian group, although this was not statistically significant. Obese in the non-vegetarian group was 15.8% compared to 7.9% in the vegetarian group, although this difference was not statistically significant (p=0.471).

Table 2. Differences in Melatonin Levels in Vegetarian and Non-Vegetarian Groups

	N	Minimum	Maximum	*Mean*	*Std. Deviation*	*p-value*
Vegetarian	38	63.39	1376.68	234	234	0.398
Non-Vegetarian	38	20.75	999.49	184	196	

In **Table 2**, it can be seen that the mean Melatonin levels in the Vegetarian group are higher than those in the non-vegetarian group, although this is not statistically significant (p=0.398).

Table 3. Differences in Cortisol Levels in Vegetarian and Non-Vegetarian Groups

	N	Minimum	Maximum	*Mean*	*Std. Deviation*	*p-value*
Vegetarian	38	24.39	80.47	379,179	1,360,796	0.779
Non-Vegetarian	38	22.94	132.56	390,232	2,000,989	

In **Table 3**, it can be seen that the average level of the stress hormone, namely Cortisol, in the Vegetarian group is lower than the level of Cortisol in the Non-Vegetarian group, although it is not statistically significant (p=0.779).

Table 4. Differences in Sleep Onset Latency in Vegetarian and Non-Vegetarian Groups

		Vegetarian	Non-Vegetarian	OR	p-value
Sleep onset	≤20min	21	11	3.032 (95% CI 1.175 - 7.7831)	0.000
	>20min	17	27		
Total		38	38		

Based on **Table 4**, it can be seen that the Vegetarian group has a faster sleep onset (≤20 minutes) compared to the Non-Vegetarian group whose sleep onset is slower (>20 minutes). The difference in sleep onset between the two groups was statistically significant with a p value = 0.000.

DISCUSSION

The characteristics of research subjects in the Vegetarian and Non-Vegetarian groups are generally not much different, except for age and education, where the Vegetarian group is mainly aged 45 years and over. This condition can be caused by the fact that at a younger age, they tend to be busier with work and traditional activities or other activities, so it is challenging to prepare vegetarian food, or the perception that the choice to become a vegetarian is a choice for older people or people with certain beliefs. Another reason may be that this is just a coincidence because there is no valid data regarding the number of Vegetarian groups in Bali and their demographic data. The non-vegetarian group in this study had more postgraduate education than the

vegetarian group, possibly because this study did not match the two groups.

Melatonin levels in this study showed no statistically significant difference between the Vegetarian and Non-Vegetarian groups, where Melatonin levels were higher in the Vegetarian group. The higher melatonin levels in the vegetarian group are to the literature, which states that a vegetarian diet produces Serotonin (5-HT) and melatonin in the central nervous system, which affects sleep. The synthesis of 5-HT depends on the availability of its precursor in the brain, namely the amino acid L-tryptophan (Trp). Trp and Large Neutral Amino Acids (LNAA) are transported across the blood-brain barrier. The Trp/LNAA ratio in the blood significantly increases melatonin and Serotonin, affecting sleep quality.[3–5] This serotonin precursor is found more in vegetarians than non-vegetarians, improving sleep quality.[6] The insignificant results in this study could be due to the small number of samples or the fact that there is no difference in Melatonin levels between the Vegetarian and Non-Vegetarian groups. The lack of data from previous research makes this research worth continuing to prove the melatonin levels in the two groups.

Cortisol levels in this study were higher in the non-vegetarian group, although this was not statistically significant. There has not been much research regarding cortisol levels in the vegetarian community. The condition that can explain the results of this research is that a vegetarian diet produces Serotonin (5-HT) and melatonin in the central nervous system, which affects sleep. Increasing Serotonin can balance the stress hormone, namely cortisol. Food from animals or meat is said to increase stress hormones. Stress hormones will be lower in vegetarians who do not consume meat.[7]

Sleep onset in the Vegetarian group was faster than in the non-vegetarian group. The rules of healthy sleep say that a good sleep onset latency is around 20 minutes. This may be related to different nutritional intake patterns in the vegetarian group. Survey research involving 1956 people found that non-vegetarians suffered from insomnia or sleepiness more often than vegetarians. Insomnia and sleepiness also occur more frequently in respondents who report consuming fruit and vegetables less than once a day compared to those who consume fruit and vegetables every day.[8] A plant-based diet can cause an increase in levels of the amino acid tryptophan, which is a precursor of melatonin and Serotonin, which plays a role in sleep regulation, improving the quality and duration of sleep, thereby reducing cardiovascular risk.[9,10] Melatonin is synthesized from Tryptophan through 5-Hydoxylation by Tryptophan-5-Hydroxylase to become 5-Hydroxytryptophan, then undergoes decarboxylation by aromatic amino acid decarboxylase to become 5-Hydroxy Tryptamine 5 (Serotonin). In the pineal gland, Serotonin undergoes N-acetylation by N-acetyl transferase (NAT) to become N-acetylserotonin, then undergoes O-methylation by Hydoxyindole-O-methyl transferase (HIOMT) to become melatonin (N-acetyl-5 methoxytryptamine).[11] Melatonin can trigger sleep by suppressing wake-promoting signals or neuronal firing in the SCN. It can regulate the wake-sleep cycle through a thermoregulatory mechanism by reducing core body temperature. The most explainable effect of melatonin's role in regulating sleep mechanisms is reducing sleep onset latency through the sleep-switch model, according to the results of this study.[12]

CONCLUSION

The non-vegetarian group had higher blood cortisol levels than the vegetarian group. In contrast, melatonin levels were higher in the vegetarian group, although neither condition was statistically significant. Sleep onset obtained subjectively (sleep questionnaire) in the two groups showed significantly different results, where the vegetarian group had a faster sleep onset than the non-vegetarian group.

Declaration by Authors

Ethical Approval: Approved

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Conflict of Interest: The authors declare no conflict of interest.

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